THE NATIONAL RIBAT UNIVERSITY

FACULTY OF GRADUATE STUDIES AND SCIENTIFIC RESEARCH

The Role of Ultrasound in diagnosis and Classification of Hydronephrosis in Sudanese Pregnant Women

A thesis submitted for partial fulfillment of the requirements of Ms.c. degree in medical diagnostic ultrasound

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2016
الآية

قال تعالى:

{ إِقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ (1) خَلَقَ الإنسانَ مِنْ عَلَقٍ (2)

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الَّذِي عَلَّمَ الِْْنسَانَ مَا لَمْ يَعْلَمْ (4)

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سورة العلق الآيات (1-5)

صدق الله العظيم
Abstract:

Dilatation of the upper urinary tract in pregnancy has been recognized since 1843, ultrasonography is a well-established means of determining the presence or absence of obstruction of the renal collection systems, and has been widely applied to the study of hydronephrosis.

An analytic, observational study was performed at multi-centers and hospitals in Khartoum state, during the period from (January–August 2014).

The aim of the study was to determine the role of ultrasound in classification of hydronephrosis in Sudanese pregnant women.

A number of 100 Sudanese pregnant women attending for obstetric ultrasound aged between 15 – 45 years were scanned to investigate the presence of hydronephrosis.

The results showed that 60 out of 100 pregnant women were suffering of hydronephrosis (60%). It was found that as the pregnant women getting older fewer incidences of hydronephrosis is reported. According to trimesters the result revealed that the first trimester showed the least record of hydronephrosis, while the third trimester is the highest record of hydronephrosis. A higher rate of hydronephrosis with increased gestational age was noticed, and all cases were found to be mild or moderate with no severe Hydronephrosis.

The overall incidence of hydronephrosis was 71.6% for the right kidney and 10% for the left kidney and 18.3% in both kidneys.

The study concluded that the method of ultrasonography used in the assessment of maternal kidneys was easy, non-invasive and reliable one.
And the obtained results can serve as a baseline for assessment of presence of hydronephrosis in Sudanese pregnant women.

المستخلص:

توسع المنطقة البولية العليا في الحمل عرف منذ 1843، الموجات الفوق الصوتية من الوسائل الرائحة في الكشف عن ما بعيق عمل الجهاز البولي، وفي دراسة توسّع المنطقة البولية على نحو واسع.

تمت هذه الدراسة التحليلية في مراكز ومستشفيات متعددة في ولاية الخرطوم، أثناء الفترة من (يناير-أغسطس 2016).

كان هدف الدراسة معرفة دور الموجات الفوق الصوتية في تصنيف توسّع المنطقة البولية العليا في النساء الحامل السودانيات.

تمت الدراسة علي 100 إمرأة سودانيّة حيّة تتراوح اعمارهم بين 15 و 45 عاماً لدراسة توسّع المنطقة البولية العليا.

اوضحت النتائج بأن 60 من 100 إمرأة حيّة يعانون توسّع المنطقة البولية العليا ووجد أيضًا كثاف veces في النساء الحامل قل حدوث توسّع المنطقة البولية العليا. أيضاً كشفت الدراسة بأن الثلث الأول من مراحل الحمل سجل أقل حدوث لتوسع المنطقة البولية العليا، بينما الثلث الثالث من مراحل الحمل الأعلى تسجيل لتوسع المنطقة البولية العليا.

ولوحظ أن مع تقدم عمر الجنين تزيد نسبة حدوث توسّع المنطقة البولية العليا. وأيضاً لوحظ أن كل حالات توسّع المنطقة البولية العليا كانت بسيطة أو معتملة ولم ترصد أي حالة حادة.

ووجد أن حدوث توسّع المنطقة البولية العليا لدى النساء الحامل كانت 71.6% للكلية اليمني و10% للكلية اليسرى و18.3% في كلتا الكلتين.

استنتجت الدراسة بأن طريقة الموجات الفوق الصوتية التي استخدمت في تقييم الكلى للنساء الحامل كانت طريقة سهلة وموثوقة النتائج لتقييم حدوث توسّع المنطقة البولية العليا لدى النساء الحامل في السودان.
Dedication

To my family

To my friends

To my teachers

...
Acknowledgment

My greatest thanks to Allah who helped me to finish this research. He also gave me strength and good health while doing this work and patience to overcome the difficulties.

My sincere thanks and appreciation to Dr. Elsir Ali Saeed who helped me too much to arrange my thoughts, words and data together.

My thanks must go to ultrasound department of Alban gadeed teaching hospital I thank them for their good natured support during collection of data.

Finally many thanks to my family who always give me emotional support and encourage me, I will always appreciate what they have done.
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ascending limb; DCT, distal convoluted tubule; IMCDi, initial inner medullary collecting duct; IMCDt, terminal inner medullary collecting duct; MTAL, medullary thick ascending limb; OMCD, outer medullary collecting duct; PCT, proximal convoluted tubule; PST, proximal straight tubule; TL, thin limb of loop of Henle.

**Fig 2.5** Electron micrograph of a portion of a glomerulus from normal human kidney in which segments of three capillary loops (CL) are evident. The relationship between mesangial cells (M), endothelial cells (E), and visceral epithelial cells (V) is demonstrated. Several electron-dense erythrocytes lie in the capillary lumens. BS, Bowman's space. (Magnification, ×6700.)

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CHAPTER ONE

1.1 Introduction

The kidneys are bean shaped organs that serve regulatory roles in vertebrates. They remove excess organic molecules from the blood; by this action they remove the organic waste products of metabolism. Kidneys are essential to the Urinary system and also serve homeostatic functions such as the regulation of electrolyte maintenance of acid-base balance and regulation of blood pressure via maintaining the salt and water balance, they serve the body as a natural filter of blood and remove water soluble waste which are diverted to the bladder. In production urine the kidneys excrete waste such as urea and ammonium. They are also responsible for reabsorption of water glucose and amino acid; the kidneys also produce hormones including calciteirol and erythropoietin. An important enzyme rennin is also produced in the kidneys which act as the negative feedback \(^{6,7}\).

Hydronephrosis is the result of several abnormal pathophysiological occurrences. Structural abnormalities of the junctions between the kidney, ureter and bladder that lead to hydronephrosis can occur during fetal development. Some of these congenital defects have been identified as inherited conditions; however the benefits on linking genetic testing to early diagnosis have not been determined. Other structural abnormalities could be caused by injury, surgery, or radiation therapy \(^{6,7}\).

Compression of one or both ureters can also be caused by other developmental defects not completely occurring during the fetal stage such as an abnormally placed vein, artery, or tumor. Bilateral compression of the ureters can occur
during pregnancy due to enlargement of the uterus. Changing the hormones level during this time may also affect the muscle contraction of the bladder, further complicating this condition \(^{(6,7)}\).

Sources of obstructions that can arise from other various causes include kidney stones blood clot or retroperitoneal fibers. The obstructions may be either partial or complete and can occur anywhere from the urethral meatus to the calyces of the renal pelvis \(^{(6,7)}\).

Hydronephrosis can also result from the reverse flow of urine from the bladder back into the kidneys. This reflux can caused by some of the factors listed above as well as the compression of the bladder outlet into the urethra by the prostatic enlargement or impaction of feces in the colon as well as abnormal contractions of bladder muscles resulting from neurological dysfunction or other muscular disorders \(^{(6,7)}\).

During pregnancy, mild hydronephrosis is considered a normal phenomenon and may be present in up to 90% of pregnancies. Dilation usually more pronounced on the right kidney, in primigravidas and after mid-pregnancy. This dilation disappears a few weeks after birth. Acceptable explanations for this phenomenon are compression of the gravid uterus on the ureters and the smooth muscle relaxing influence of progesterone. The predisposition for the right side may be explained by the dextrorotaryion of the uterus and the relative protection of the left ureter provided by the sigmoid colon. Increased diuresis, small stones or other unrecognized factors may cause decompensation of ureteral function, progressing to symptomatic acute hydronephrosis \(^{(6,7)}\).
Grading systems of hydronephrosis have been devised to communicate the degree of upper collecting system dilatation. The most common system used {Society of Fetal Ultrasound (SFU)} was originally designed for grading neonatal and infant hydronephrosis\(^{(6,7)}\).

a. **Grade 0 (normal)**
   - No dilatation, calyceal walls are opposed each other.

b. **Grade 1 (mild)**
   - Dilatation of the renal pelvis without the dilatation of the Calyces (can also occur in the external pelvis) No parenchyma atrophy.

c. **Grade 2 (mild)**
   - Dilatation of the renal pelvis (mild) and calyces and pelvicalyceal pattern is retained) no parenchyma atrophy.

d. **Grade 3 (moderate)**
   - Moderate dilatation of the renal pelvis and calyces.
   - Bluntering of fornices and flattening of papillae
   - Mild cortical thinning may be seen.

e. **Grade 4 (severe)**
   - Gross dilatation of the renal pelvis and calyces which appears balloonned.
   - Loss of boarder between the renal pelvis and calyces.
   - Renal atrophy seen as cortical thinning.

Hydronephrosis grading system (including the SFU) are controversial in terms of their intra-rater and inter-rater reliability\(^{(6,7)}\).
1.2 Problem of the study

Many conditions may mimic hydronephrosis such as extra renal pelvis, para pelvis reflux, pyelectasis, congenital mega calyces, papillary necrosis, renal artery aneurysm. Color Doppler can help distinguish that is enlargement of vascular not the renal pelvis or an anterior venous malformation (color can distinguish this abnormality).

1.3 Objectives:

1.3.1 General objective

The role of ultrasound in classification and diagnosis of hydronephrosis in Sudanese pregnant women.

1.3.2 Specific objectives

- To detect the presence of hydronephrosis
- To assess and differentiate between the grade of hydronephrosis.
- To evaluate the accuracy of ultrasound in diagnosis and classification of hydronephrosis in pregnant women.
- To identify the corticomedullary differentiation
CHAPTER TWO

LITERATURE REVIEW

2.1 Anatomy:

Kidneys are paired retroperitoneal organs situated in the posterior part of the abdomen on each side of the vertebral column. In the human, the upper pole of each kidney lies opposite the twelfth thoracic vertebra, and the lower pole lies opposite the third lumbar vertebra. The right kidney is usually slightly more caudal in position. The weight of each kidney ranges from 125 g to 170 g in the adult male and from 115 g to 155 g in the adult female. The human kidney is approximately 11 cm to 12 cm in length, 5.0 cm to 7.5 cm in width, and 2.5 cm to 3.0 cm in thickness. Located on the medial or concave surface of each kidney is a slit, called the hilus, through which the renal pelvis, the renal artery and vein, the lymphatics, and a nerve plexus pass into the sinus of the kidney. The organ is surrounded by a tough fibrous capsule, which is smooth and easily removable under normal conditions\(^{(4, 10, 16)}\).

In the human, as in most mammals, each kidney is supplied normally by a single renal artery, although the presence of one or more accessory renal arteries is not uncommon. The renal artery enters the hilar region and usually divides to form an anterior and a posterior branch. Three segmental or lobar arteries arise from the anterior branch and supply the upper, middle, and lower thirds of the anterior surface of the kidney (Fig. 2-1). The posterior branch supplies more than half of the posterior surface and occasionally gives rise to a small apical segmental branch. However, the apical segmental or lobar branch arises most commonly from the anterior division\(^{(4, 10, 16)}\).
No collateral circulation has been demonstrated between individual segmental or lobar arteries or their subdivisions. Not uncommonly, the kidneys receive aberrant arteries from the superior mesenteric, suprarenal, testicular, or ovarian arteries. True accessory arteries that arise from the abdominal aorta usually supply the lower pole of the kidney \(^{(4,10,16)}\).

![Diagram of the vascular supply of the human kidney](image)

**Fig 2.1** Diagram of the vascular supply of the human kidney. The anterior half of the kidney can be divided into upper (U), middle (M), and lower (L) segments, each supplied by a segmental branch of the anterior division of the renal artery. A small apical segment (A) is usually supplied by a division from the anterior segmental branch. The posterior half of the kidney is divided into apical (A), posterior (P), and lower (L) segments, each supplied kidney by branches of the posterior division of the renal artery.

Two distinct regions can be identified on the cut surface of a bisected kidney: a pale outer region, the cortex, and a darker inner region, the medulla (Fig. 2.2). In humans, the medulla is divided into 8 to 18 striated conical masses, the renal pyramids. The base of each pyramid is positioned at the corticomedullary boundary, and the apex extends toward the renal pelvis to form a papilla. On the tip of each papilla are 10 to 25 small openings that
represent the distal ends of the collecting ducts (of Bellini) In humans, the renal cortex is about 1 cm in thickness, forms a cap over the base of each renal pyramid, and extends downward between the individual pyramids to form the renal columns of Bertin (Fig. 2.2; see Fig. 2.3). From the base of the renal pyramid, at the corticomedullary junction, longitudinal elements termed the “medullary rays of Ferrein” extend into the cortex. Despite their name, the medullary rays are actually considered a part of the cortex and are formed by the collecting ducts and the straight segments of the proximal and distal tub (4,10,16).

Fig 2.2 Bisected kidney demonstrating the difference in appearance between the light-staining cortex and the dark-staining outer medulla. The inner medulla and papillae are less dense than the outer medulla. The columns of Bertin can be seen extending downward to separate the papilla
The renal pelvis is lined by transitional epithelium and represents the expanded portion of the upper urinary tract. In humans, two and sometimes three out pouching, the major calyces extend outward from the upper dilated end of the renal pelvis. From each of the major calyces, several minor calyces extend toward the papillae of the pyramids and drain the urine formed by each pyramidal unit. In mammals possessing a unipapillate kidney, the papilla is directly surrounded by the renal pelvis. The ureters originate from the lower portion of the renal pelvis at the ureteropelvic junction, and in humans they descend a distance of approximately 28 cm to
34 cm to open into the fundus of the bladder. The walls of the calyces, pelvis, and ureters contain smooth muscle that contracts rhythmically to propel the urine to the bladder \(^{(4,10,16)}\).

### 2.2 Physiology of the kidney

#### 2.2.1 The Nephron:

The functional unit of the kidney is the nephron. Each human kidney contains about \(0.6 \times 10^6\) to \(1.4 \times 10^6\) nephrons, which contrasts with the approximately 30,000 nephrons in each adult rat kidney. The essential components of the nephron include the renal or malpighian corpuscle (glomerulus and Bowman's capsule), the proximal tubule, the thin limbs, the distal tubule, and the connecting tubule. The origin of the nephron is the metanephric blastema. Although there has not been universal agreement on the origin of the connecting tubule, it is now generally believed to derive from the metanephric blastema. The collecting duct system, which includes the initial collecting tubule, the cortical collecting duct (CCD) in the medullary ray, the outer medullary collecting duct (OMCD), and the inner medullary collecting duct (IMCD), is not, strictly speaking, considered part of the nephron because embryologically it arises from the ureteric bud. However, all of the components of the nephron and the collecting duct system are interrelated functionally \(^{(4,10,16)}\).

Two main populations of nephrons are recognizable in the kidney: those possessing a short loop of Henle and those with a long loop of Henle (Fig. 2.4). The loop of Henle is composed of the straight portion of the proximal tubule (pars recta), the thin limb segments, and the straight portion of the distal tubule (thick ascending limb, or pars recta). The length of the
loop of Henle is generally related to the position of its parent glomerulus in the cortex. Most nephrons originating from superficial and midcortical locations have short loops of Henle that bend within the inner stripe of the outer medulla close to the inner medulla. A few species, including humans, also possess cortical nephrons with extremely short loops that never enter the medulla but turn back within the cortex. Nephrons originating from the juxtamedullary region near the corticomedullary boundary have long loops of Henle with long descending and ascending thin limb segments that enter the inner medulla. Many variations exist, however, between the two basic types of nephrons, depending on their relative position in the cortex. The ratio between long and short loops varies among species. Humans and most rodents have a larger number of short-looped than long-looped nephrons (4,10,16).
2.2.2 Renal Corpuscle (Glomerulus)

The renal corpuscle is composed of a capillary network lined by a thin layer of endothelial cells; a central region of mesangial cells with surrounding mesangial matrix material; the visceral epithelial cells and the associated basement membrane; and the parietal layer of Bowman's capsule with its basement membrane (Figs. 2.5 through 2.8). Between the two epithelial layers is a narrow cavity called Bowman's space, or the urinary space. Although the term renal corpuscle is more precise anatomically than
the term glomerulus when referring to that portion of the nephron composed of the glomerular tuft and Bowman's capsule, the term glomerulus is employed throughout this chapter because of its common use. The visceral epithelium is continuous with the parietal epithelium at the vascular pole, where the afferent arteriole enters and the efferent arteriole exits the glomerulus. The parietal layer of Bowman's capsule continues into the epithelium of the proximal tubule at the so-called urinary pole. The average diameter of the glomerulus is approximately 200 mm in the human kidney.

![Electron micrograph of a portion of a glomerulus from normal human kidney in which segments of three capillary loops (CL) are evident. The relationship between mesangial cells (M), endothelial cells (E), and visceral epithelial cells (V) is demonstrated. Several electron-dense erythrocytes lie in the capillary lumens. BS, Bowman's space. (Magnification, ×6700.)](image)

**FIGURE 2.5**

The glomerulus is responsible for the production of an ultrafiltrate of plasma. The filtration barrier between the blood and the urinary space is composed of a fenestrated endothelium, the peripheral glomerular basement membrane (GBM), and the slit pores between the foot processes of the
visceral epithelial cells). The mean area of filtration surface per glomerulus has been reported to be 0.203 mm\(^2\) in the human kidney\(^{(4,10,16)}\).

2.3 Pathology of the kidney:

Acute flank pain and abdominal pain with hematuria are relatively common presenting complaints in the emergency department. Although urinary obstruction is a likely diagnosis in such patients, the differential diagnosis includes life-threatening disease processes, most importantly an expanding or ruptured abdominal aortic aneurysm. Emergency bedside sonography is a tool that can rapidly confirm the diagnosis of acute urinary obstruction and help exclude life-threaten. It is important to know common medical terms used to describe the pathophysiology of urinary retention. The structural impediment to the flow of urine is termed *obstructive uropathy*. Unless this obstruction develops slowly it is typically painful, which is called *renal colic*. The most common cause is a kidney stone dislodged into the ureter called *ureterolithiasis*. Urine flow is blocked by the stone leading to back-up and dilation of the proximal ureter (*hydroureter*). As the obstruction progresses, more proximal structures like the renal collecting system (renal pelvis and calyces) becomes dilated, termed *hydronephrosis*. If the hydronephrosis is severe, the renal parenchyma becomes compressed and if lasting long enough (about 2-4 weeks), can cause loss of renal function. As described above, the most common cause of renal colic and hydronephrosis is ureterolithiasis. But in general everything able to obstruct the inner lumen of the collecting system or causing extrinsic compression can block urinary flow and lead to renal colic\(^{(5,11,12,15)}\).
2.3.1 The diagnosis of acute renal colic has three major components:

a. The patient’s clinical presentation.

b. The presence of blood on urinalysis. 89% of patients with ureterolithiasis have > 0 RBC per high power field on urine microscopy.

c. Diagnostic imaging, which may include intravenous pyelogram (IVP), CT scan or ultrasound.

The goal of bedside renal ultrasonography is to rapidly evaluate the patient presenting to the ED with flank pain, abdominal pain with hematuria or decreased urinary output to answer a few basic questions:

- Is there hydronephrosis?
- Unilateral or bilateral?
- Is there fluid around the kidney?
- Is the bladder distended?
- Are stones seen?
- Is the aorta normal

- The advantages of emergency renal ultrasonography include:
  - Bedside
  - No radiation
  - No IV contrast
  - Repeatable
  - Fast
The disadvantages of emergency renal ultrasonography are that it does not assess renal function (as IVP does) and it cannot typically identify/size the ureteral stone \((5,11,12,15)\).

2.3.2 Possible Kidneys Diseases:

2.3.2.1 Renal or ureteral stones: may be seen on ultrasonography in the patient with acute renal colic. Look for bright objects that cast a shadow within the kidney (Figures 2.6). If you can, follow the dilated ureter down toward the bladder. A bright object that casts a shadow within the ureter or at the junction of the bladder is consistent with ureteral nephrolithiasis. It is often difficult to identify ureteral stones.

Fig 2.6: Several examples of kidney stones are shown. Kidney, kidney stone with the cast shadow are labeled in each figure.
2.3.2.2 **Simple or complex renal cysts:** Peripheral, smooth, hypoechoic and with or without internal echoes; multiple in polycystic disease (Figure 2.7).

![Several examples of renal cysts. Kidneys with cyst (green) and posterior enhancement are shown.](image)

**Figure 2.7:** Several examples of renal cysts. Kidneys with cyst (green) and posterior enhancement are shown.

2.3.2.3 **Pyelonephritis:** sonographic appearance is most commonly normal, but you may find hypoechoic cortex and loss of demarcation between the outer cortex and middle pyramids and columns of Bertin.

2.3.2.4 **Renal mass:** May have any echotexture (hyperechoic, anechoic etc.) and appear anywhere within the kidney.

2.3.2.5 **Chronic renal failure:** Kidneys appear small and hyperechoic.

2.3.2.6 **Ureteral stents:** have a characteristic appearance but can be difficult to visualize due to size and position (Figure 2.8) (5,11,12,15).
Fig 2.8: Images showing a ureteral stent (green) in the proximal dilated ureter (blue).

2.3.2.7 Hydronephrosis:

Hydronephrosis is a condition that typically occurs when the kidney swells due to the failure of normal drainage of urine from the kidney to the bladder. This swelling most commonly affects only one kidney, but it can involve both kidneys. Hydronephrosis isn’t a primary disease. It’s a secondary condition that results from some other underlying disease. It’s a structural condition that’s the result of a blockage or obstruction in the urinary tract (5,11,12,15).

The primary sonographic abnormality you will identify in the patient with suspected acute renal colic is hydronephrosis. The degree of hydronephrosis relates to the degree and extent of obstruction (figure 2.9 to 2.11) (5,11,12,15).
Figure 2.9: Longitudinal view of right kidney with mild hydronephrosis.

Figure 2.10a: Longitudinal axis of kidney with moderate hydronephrosis. Figure 2.10b: Transverse view of same kidney with moderate hydronephrosis.

- **What Are the Symptoms of Hydronephrosis?**

  Normally, urine flows through the urinary tract with minimal pressure. Pressure can build up if there’s an obstruction in the urinary tract. After urine builds up for an extended period, kidney can enlarge, and may become so engorged with urine that it starts to press on nearby organs. If it’s left untreated for too long, this pressure can cause kidneys to lose function permanently \(^{(5,11,12,15)}\).
Mild symptoms of hydronephrosis include urinating more frequently and an increase in the urge to urinate. Other potentially severe symptoms are:

a. pain in the abdomen or flank  
b. nausea  
c. vomiting  
d. pain when urinating  
e. incomplete voiding  
f. a fever

Interrupting the flow of urine increases the chances of getting a urinary tract infection (UTI). This is why UTIs are one of the most common complications of hydronephrosis. Some signs of a UTI include:

a. cloudy urine  
b. painful urination  
c. burning with urination  
d. a weak urine stream  
e. back pain  
f. bladder pain  
g. a fever  
h. chills

• What Causes Hydronephrosis?

Hydronephrosis isn’t a disease. Instead, it can be due to internal and external conditions that affect the kidney and the urinary collecting system. One of the most common of causes of hydronephrosis is acute unilateral obstructive uropathy. This is a sudden development of an obstruction in one of the ureters, which are the tubes that connect your kidneys to your bladder. The most common cause for this blockage is a kidney stone, but scarring and blood clots can also cause acute unilateral obstructive uropathy. A blocked
ureter can cause urine to go back up into the kidney, which causes swelling. This backflow of urine is known as vesicoureteric reflux (VUR) \(^{5,11,12,15}\).

**Other causes of blockage may include:**

- a kink in the ureteropelvic junction, which is where the ureter meets the pelvis of the kidney
- an enlarged prostate gland in men, which can be due to BPH or prostatitis
- pregnancy, which causes a compression due to a growing fetus
- tumors in or near the ureter
- a narrowing of the ureter from an injury or birth defect

Ultrasound is very sensitive in diagnosing obstruction by demonstrating hydronephrosis. Ultrasonography has great advantage over IVU in patient who have azotemia, contrast materiaialinduced allergy, are pregnant, fetal, or pediatric patients with no exposure to radiation. Ultrasonography can nicely visualize the both the renal parenchyma and the collecting system as well as causative lesion itself (both intrinsic and extrinsic) \(^{5,11,12,15}\).

Hydronephrosis is graded as mild (grade 1), moderate (grade2), or sever (grade3). Mild hydronephrosis can be simulated by prominent renal vessels and false –positive studies for obstruction are common in patients suspected of having mild hydronephrosis , Doppler or color Doppler ultrasonography will distinguish prominent renal vessels from mild hydronephrosis (Fig.2-12) \(^{5,11,12,15}\).
**Fig 2.11**: False – positive study for obstruction, which is suspected of having mild hydronephrosis. Fig. 2.11a: the renal pelvis and calyceal system demonstrate minimal separation of the central sinus echo complex by tubular anechoic structure. Fig.2.11b color Doppler ultrasound demonstrates color flow in the tubular structures.

- **Hydronephrosis during pregnancy:**

  A condition of developing Hydronephrosis during pregnancy, due to the presence of the fetus within the womb, is Maternal Hydronephrosis. The asymptomatic dilation of the renal calyces, the renal pelvis and the upper two-thirds of ureter during pregnancy results in this typical condition (5,11,12,15).

  Also referred to as gestational hydronephrosis, it associates with the common trouble of urinary tract infection in pregnant women. Therefore, it is estimated, around 90% of pregnant women suffer from some form of Hydronephrosis during pregnancy. The dilation is often more prominent on the right side of the body (85%) than the left side (15%). The ureteral dilation does not occur below the pelvic brim. An existence of Hydronephrosis due to some pathological condition prenatally worsens the disorder (5,11,12,15).
Symptoms:

Here are a few of hydronephrosis during pregnancy symptoms. However, in some cases, there will be no symptoms at all. Symptoms depend on whether the swelling occurs acutely, progressively or more gradually.

- Acute flank pain or pain in the back and abdominal region
- Nausea and vomiting
- Constant urinary tract infection with painful urination
- Fever
- Colicky pain
- Stains of blood in the urine
- Chest pain
- Swelling of the legs
- Increased frequency of urination

Causes of Hydronephrosis During Pregnancy:

The hormonal changes during pregnancy involving estrogen, progesterone, and prostaglandin like agents cause disorders like Hydronephrosis and Ureter Ectasis.

Pregnancy results in generalized relaxation of smooth muscles due to the effect of progesterone. Along with dextro-rotation of the uterus, the incidence of hydronephrosis in pregnant women becomes greater. The growing weight of the uterus in a limited pelvic space can cause dilation of the uterus and hence contribute to the incidence of Hydronephrosis. Increasing gestational age and growth of the uterus outside the pelvis can decrease this pressure on the ureters. Increased hydration can result in an increased degree of Hydronephrosis.

Pregnancy increases the renal blood flow to up to 75% and approximate 50% increase in the Glomerular Filtration Rate (GFR). The GFR is a test used to check how well the kidneys are working. Therefore, the incidence of fetal Hydronephrosis in pregnancy increases \((5,11,12,15)\).
The obstruction or the blockage in the urinary tract can occur congenitally in a fetus or may be one of the physiological responses to pregnancy. Kidney stones, blood clots or a stricture or scarring of the kidneys, bladder cancer, urethral stricture, etc. are few of the intrinsic causes of Hydronephrosis. Similarly, external causes of Cervical Cancer, the Ovarian Vein Syndrome and functional causes like Diabetes and Vesicoureteral Reflux can also result in Hydronephrosis (5,11,12,15).

➢ **Facts about Hydronephrosis during pregnancy:**

- The gestational Hydronephrosis usually occurs in the second trimester. It affects almost 90% of pregnancies by the 26th and 28th weeks.

- The incidence of dilation is greater in nulliparous patients. A woman who has not carried the pregnancy beyond 20 weeks is termed nulliparous.

- Mostly Hydronephrosis disappears on its own, without any form of treatment. The ideal period is six weeks after delivery, but sometimes, it may persist longer.

➢ **Diagnosis of Hydronephrosis during pregnancy:**

- Ultrasound scan can help in differentiating physiologic Hydronephrosis from obstruction secondary to calculus disease.

- Analysis of urine to determine an infection.

- Blood test to check for anemia.

- Electrolyte analysis and the GFR to detect the proper functioning of kidneys.

➢ **Risk Hydronephrosis during pregnancy:**

A rare but potentially life-threatening complication associated with Gestational Hydronephrosis is a spontaneous renal rupture. It occurs due to increased hydrostatic pressure within the collecting structures that exceeds the holding capacity of the calyceal-renal capsular junctions (5,11,12,15).
Kidneys with prior damage before pregnancy are more susceptible to suffer from a spontaneous renal rupture.

If left untreated beyond a reasonable period, the kidney will permanently fail to function.

➢ Treatment of Hydronephrosis during Pregnancy:

The treatment of Hydronephrosis during pregnancy is carefully performed through different stages:

1. Draining the urine through a thin catheter inserted into the bladder or directly to the kidney through the skin. It relieves the pressure of the urine in the kidneys.
2. Treating the underlying cause which primarily caused the blockage is the next step in line. A surgery called Ureteral Stenting usually removes the obstruction. Different causes will have different treatments. For instance, if it is a kidney stone that triggered Hydronephrosis, sound waves or lasers are used to break it.
3. But if it is purely pregnancy that caused the disorder, nothing much can be done to treat the disorder. You just have to wait till it completes its natural course to heal. However, the process of draining the excess urine through a catheter will be done to reduce the pressure on the kidneys and preventing chances of further damage (5,11,12,15).

➢ Prevention of Hydronephrosis during pregnancy:

Kidney diseases often have no symptoms. Hence, it can go undetected if not tested at the right time. Early detection and treatment can slow or prevent the progression of kidney’s disease. A regular urine test and blood test can help in finding the prevalence of any kidney disorders in pregnancy (5,11,12,15).
2.4 Previous study:

Observational study conducted by Tarek R. Abbas et al (2012) Results: Eighty of the 86 women (93%) had symptomatic improvement. None required regular analgesia and went to term without further intervention (e.g. nephrostomy, stenting .... ). Follow-up by Ultrasound scan (USS) at three months post-partum revealed complete resolution of hydro-nephrosis (14).

Study done by Andrew M et al, (1985) the average dilatation of the pelvicalyceal system was always greater on the right than on the left. Dilatation was identified in the first trimester, and the average dilatation of the study population as a whole advanced with advancing gestational age. The average dilatation was maximal during the third trimester and had completely resolved in all but two patients by the six-week-postpartum visit. Although the general trend for the entire patient group was for gradually increasing hydronephrosis throughout the gestational period (1).

This study was a cohort study carried out by Grosjean J.; Cannie M.; de Meyer J. (2013) Results: Thirty women presented a hydronephrosis: nineteen right, two left and nine bilateral. The occurrence augmented from 6/35 (15%) in the second to 24/65 (27%) in the third trimester. Anatomical data show that physiological hydronephrosis is specifically limited to the renal pelvis and the upper two centimeters of the ureter. The right ureter seems to be compressed between the uterus and the psoas muscle rim .The compression does not occur at the level of the crossing iliac vessels. The right/left difference cannot be explained by the localisation (no dextrorotation) of the uterus and is not in relation with the intestinal structures. The difference can only be due to subtle anatomical differences in the relation between the ureter and the psoas rim and a discrete an-gulation of the right pyelo-ureteral junction (9).

This prospective observational study was approved by Aurangzaib Siyal et al, (2009). Results: 500 pregnant women were examined under ultrasound, hydronephrosis was found in 321(64.2%) patients. Of the 321 patients right side hydronephrosis was present in 224 (69.78%) patients; whereas 97 (30.21%) patients had left side hydronephrosis. The position of fetal
vertebral column had no compression effect on maternal ureters either on right or left side. Almost equal percentage of hydronephrosis was observed on right and left kidneys irrespective of position of vertebral column (2).

Study done by Shawnm Nasih Dawood et al (2014). Results: Renal collecting system dilatation was the main abnormal finding; it was present in 18.2% of cases, (15.2% right side and 3% left side). Bilateral hydronephrosis was seen in (2.6%) of cases. Rate of hydronephrosis was more in primiparous women. Other findings were renal stones (2.8% right and 1.8% left sides, respectively), ureteric stone (0.2%) and acute pyelonephritis (1%) (13).
CHAPTER THREE

Material and methods

3.1 Study type:

Cross sectional descriptive analytic study deal with pregnant women who came to the ultrasound department for obstetric scan.

3.2 Method of the study:

Each pregnant women was scanned twice, firstly by student and secondly by sonologist to confirm the diagnosis.

3.3 Area of the study:

The study was carried out in ultrasound departments in Khartoum state hospitals.

3.4 Duration of the study:

The study was carried out in ultrasound departments in Khartoum state from January to August 2016.

3.5 Population of the study:

Pregnant women who complain of renal symptoms disease, colic pain, flank pain, hematurea………etc presented to the ultrasound department at the area of study.

3.6 Sampling:

The study was carried out in ultrasound departments in Khartoum state hospitals on 100 pregnant women referred for routine obstetric sonography were enrolled in the study.
3.7 Technique:

3.7.1 Patient Positioning:

- Supine as basic
- other positions as needed

3.7.2 Coupling agents

A coupling agent is necessary to ensure good acoustic contact between the transducer and the skin and allow total transsimation of the sound beam

3.7.3 protocol of scanning

After the patients were informed of the procedure they consented and were scanned by transabdominal approach by routine sonographic evaluation, following the scans the findings were recorded. Scanning was done in room with dim light to minimize the reflected artifact of the screen, the cases were examined in supine position then applying coupling agent to abdomen and begin evaluation with simple sweep of transducer up and down and side to side across the abdomen to get a rough sense of the uterine contents before focusing on specific areas of interest, after getting a rough sense that the observation were made and the pregnancy was evaluated:

1. Number of fetuses (single)
2. Cardiac activity
3. Placenta location
4. Assessment of amniotic fluid volume
5. Determination of GA based on various fetal measurements.
6. Screening for gross abnormalities.
3.7.4 The protocol used to evaluate the both kidneys:

A 3.5-5 MHz probe is typically used to scan the kidney. For the right kidney, the patient had to be lied in supine position and then the probe was placed in the right lower intercostal space in the midaxillary line. The liver used as acoustic window and the probe was aimed slightly posteriorly (toward the kidney). Gently the probe was rocked (up and down or side to side) to scan the entire kidney. If needed, the patient inspire or exhale, this allows for subtle movement of the kidney. Longitudinal (long axis) and transverse (short axis) were obtained. (Figure 1-2)

Figure 3.1a and 3.1b: Longitudinal images of normal right kidney. Figure 3.2: Transverse image of normal right kidney

For the left kidney the patient had to be lied supine or in the right lateral decubitus position. the probe was placed in the lower intercostal space on the posterior axillary line. The placement will be more cephalad and posterior than when visualizing the right kidney. Again the probe had been gently rocked to scan the entire kidney. Longitudinal (long axis) and transverse (short axis) were obtained.
3.7.5 Equipment

A real-time system with 3.5 MHz, TA, convex transducer (SHIMADZU, Model VA57R-0375U), Recording system by Sony ultrasound printer up-897MD.

3.8 Study variable:

a) Presence of hydronephrosis in pregnant women.

b) The grade of hydronephrosis in pregnant women.

c) Sign and symptom of hydronephrosis during pregnancy.

3.9 Data collection:

The data will be collected by clinical collection sheet which contain all variables of the study.

- from data sheet

- request form

3.10 Data analysis:

The data will be entered in the statistical package for social sciences (SPSS) and analyzed through its statistical program.

3.11 Data presentation:

The data will be presented in graphs and tables.

3.12 Data storage:

The data will be stored in CD
3.13 Ethical consideration:

There is no any patient name or individual detail throughout the study.
Chapter Four

Results

The following tables and figures present the data obtained from 100 pregnant women who were examined by ultrasound. Hydronephrosis was classified according to maternal age, gestational age, trimesters, symptoms presented and its location. Women age, Number of gravity and parity was also measured. The data were analyzed using Microsoft Excel program and SPSS version 22 for significance of tests. Frequency tables, means and standard deviation were presented.
Table 4.1 Summary of Parameters

<table>
<thead>
<tr>
<th>Number of Patients</th>
<th>Age (years)</th>
<th>Number of Gravity</th>
<th>Number of Parity</th>
<th>Gestational Age (weeks)</th>
<th>No. of cases with Hydronephrosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>26.66 +/- 6.39</td>
<td>3.68 +/- 2.31</td>
<td>2.41 +/- 2.23</td>
<td>24.39 +/- 10.41</td>
<td>60</td>
</tr>
</tbody>
</table>

Fig 4.1 Distributions of hydronephrosis in total patients
Table 4.2 Distributions of Parameters according to maternal age groups:

<table>
<thead>
<tr>
<th>Age Groups (years)</th>
<th>No. of Patients</th>
<th>Number of Gravity</th>
<th>Number of Parity</th>
<th>Gestational Age (weeks)</th>
<th>No. of cases with Hydronephrosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-20</td>
<td>18</td>
<td>1.55 +/- 1.04</td>
<td>0.5 +/- 0.98</td>
<td>18.55 +/- 9.16</td>
<td>7</td>
</tr>
<tr>
<td>21-25</td>
<td>28</td>
<td>2.42 +/- 1.39</td>
<td>1.28 +/- 1.27</td>
<td>25.64 +/- 10.74</td>
<td>16</td>
</tr>
<tr>
<td>26-30</td>
<td>32</td>
<td>4.37 +/- 1.62</td>
<td>2.93 +/- 1.72</td>
<td>25.46 +/- 10.53</td>
<td>22</td>
</tr>
<tr>
<td>31-35</td>
<td>11</td>
<td>5.09 +/- 2.21</td>
<td>3.72 +/- 2.10</td>
<td>25.27 +/- 10.05</td>
<td>6</td>
</tr>
<tr>
<td>36-40</td>
<td>10</td>
<td>6.70 +/- 2.26</td>
<td>5.30 +/- 2.49</td>
<td>26 +/- 10.16</td>
<td>8</td>
</tr>
<tr>
<td>41-45</td>
<td>1</td>
<td>9</td>
<td>8</td>
<td>34</td>
<td>1</td>
</tr>
</tbody>
</table>
Fig 4.2 Presence of Hydronephrosis According to Maternal Age

Table 4.3 Distributions of Parameters according to trimester:

<table>
<thead>
<tr>
<th>Trimester</th>
<th>Number of Patients</th>
<th>Age</th>
<th>Number of Gravity</th>
<th>Number of Parity</th>
<th>Gestational Age</th>
<th>No. of cases with Hydronephrosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>20</td>
<td>25</td>
<td>3.50 +/- 6.79</td>
<td>2.30 +/- 2.39</td>
<td>8.40 +/- 1.78</td>
<td>2</td>
</tr>
<tr>
<td>Second</td>
<td>34</td>
<td>26.02 +/- 5.82</td>
<td>3.38 +/- 2.14</td>
<td>2.11 +/- 2.08</td>
<td>20.85 +/- 3.78</td>
<td>23</td>
</tr>
<tr>
<td>Third</td>
<td>46</td>
<td>27.84 +/- 6.50</td>
<td>3.97 +/- 2.40</td>
<td>2.67 +/- 2.30</td>
<td>33.95 +/- 3.20</td>
<td>35</td>
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</table>
Fig 4.3 Presence of Hydronephrosis According to Trimester

Table 4.4 Distributions of Parameters according to Gestational Age Groups:

<table>
<thead>
<tr>
<th>Gestational Age Groups (weeks)</th>
<th>No. of Patients</th>
<th>No. of cases with Hydronephrosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-10</td>
<td>19</td>
<td>2</td>
</tr>
<tr>
<td>11-15</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>16-20</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>21-25</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>26-30</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>31-35</td>
<td>22</td>
<td>18</td>
</tr>
<tr>
<td>36-40</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>41-45</td>
<td>1</td>
<td>1</td>
</tr>
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</table>
Fig 4.4 Presence of Hydronephrosis According to Gestational Age.
Table 4.5 Distribution of Hydronephrosis according to severity:

<table>
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<tr>
<th>Classification of Hydronephrosis</th>
<th>No of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>56</td>
</tr>
<tr>
<td>Moderate</td>
<td>4</td>
</tr>
<tr>
<td>Sever</td>
<td>Non</td>
</tr>
</tbody>
</table>

Fig 4.5 Distribution of Hydronephrosis according to severity
Table 4.6 Distribution of Hydronephrosis according to location:

<table>
<thead>
<tr>
<th>Location of Hydronephrosis</th>
<th>No of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Kidney</td>
<td>43</td>
</tr>
<tr>
<td>Left Kidney</td>
<td>6</td>
</tr>
<tr>
<td>Both Kidneys</td>
<td>11</td>
</tr>
</tbody>
</table>

Fig 4.6 Location of Hydronephrosis
Table 4.7 Distribution of Symptoms Presented:

<table>
<thead>
<tr>
<th>Symptoms Presented</th>
<th>No of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right loin pain</td>
<td>14</td>
</tr>
<tr>
<td>Left loin pain</td>
<td>6</td>
</tr>
<tr>
<td>Bilateral loin pain</td>
<td>16</td>
</tr>
<tr>
<td>Pain less</td>
<td>24</td>
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</tbody>
</table>

Fig 4.7 Distribution of Symptoms Presented.
CHAPTER FIVE:

Discussion, Conclusion and Recommendation

5.1 Discussion

The objective of this study was to detect the presence of Hydronephrosis and to evaluate the accuracy of ultrasound in diagnosis and classification of hydronephrosis in Sudanese pregnant women.

This study was performed on 100 patients. The data collected from pregnant women of ages ranged between 15-45 years old.

This study showed that 60 out of 100 pregnant women were suffering of hydronephrosis (table 4.1, fig. 4.1). Also was found that as the pregnant women getting old fewer incidences of hydronephrosis is reported. The higher incidence of hydronephrosis was found to be occurring between 26 to 30 years old. (table 4.2, fig. 4.2)

The study of hydronephrosis according to trimesters revealed that the first trimester showed the least record of hydronephrosis, while the third trimester is the highest record of hydronephrosis (table 4.3, fig.4.3) and this is in agreement with Study done by Grosjean J.; Cannie M.; de Meyer J., This study also showed higher rate of hydronephrosis with increased gestational age (table 4.4, fig. 4.4) and this is in agreement with study done by Andrew M et al.

All cases of hydronephrosis were either mild or moderate; there were no cases of severe hydronephrosis and this as shown in (table 4.5, fig. 4.5).

All patients presented in this study had no previous history of kidney problems before the pregnancy.
The overall incidence of hydronephrosis was 71.6% (43 patients) for the right kidney and 10% (6 patients) for the left kidney and 18.3% (11 patients) in both kidneys (table 4.6, fig. 4.6) this in agreement with a study done by Andrew M et al, Aurangzaib Siyal et al and Shawnm Nasih Dawood et al.

Our study showed statistically significant of 40% of patients has no pain, 26% of the patients have bilateral loin pain, 23% have right loin pain and 10% have left loin pain (table 4.7, fig. 4.7).

Despite the fact that dilatation of the upper urinary tract in pregnancy has been well recognized and documented by a number of different means, the etiology of this phenomenon remains the subject of some disagreement, recent writings suggest that the theory of mechanical pressure from the enlarging uterus compressing the ureter between the maternal pelvis and the gravid uterus has gained in favor over the hormonal and vascular theories of pregnancy–related hydronephrosis. [Andrew M et al, (1983)]

In previous sonographic studies, fried and Erickson et al. encountered dilatation of one or both collecting systems in as many as 93 per cent of asymptomatic pregnant women, The right kidney was found to be involved slightly more than twice as frequently as the left. An increasing prevalence of the dilatation by trimester was both expected and documented. Both of these works were prevalence studies, to our knowledge, sequential studies following the kidneys through and beyond pregnancy have not previously been reported.[Andrew M et al, (1983)]
5.2 Conclusion:

The study concluded that Hydronephrosis was the most accidental finding during pregnancy period and its more in the right kidney than the left. Also we found it more in second and third trimesters and with increasing gestational age.

The ultrasound was non-invasive and reliable to accurately diagnose and classify Hydronephrosis during pregnancy.

5.3 Recommendations:

- Further study in evaluation of Hydronephrosis during pregnancy with larger sample of Sudanese population for more accurate results is needed.
- Better to collect data from women at second and third trimester because hydronephrosis is not common at first trimester.
- All pregnant women whom come for ultrasound is recommended to scan their both kidneys to rule out Hydronephrosis.
- All obstirion should be trained to scan the renal system during pregnancy.
- Follow up evaluation after two weeks of delivery.
References:


6. **Devin Dean**, the Burwin institute of diagnostic medical ultrasound; Lunenburg, Canada. 1st edition

7. **Devin Dean**, abdominal ultrasound, the Burwin institute diagnostic medical ultrasound; Lunenburg, Canada. 1st edition


10. **Lanna Cheuck, Do (2013)**, Anatomy and Physiology of the kidney, Lippincott Williams.


Data Collecting Sheet

PATIENT GENERAL INFORMATION:

1. Serial Number: ..........................

2. Age:  □□□□ years

3. Residence:  A. Khartoum ( )  B. Bahri ( )  C. Omdurman ( )

4. Number of gravidity and parity: □□□□□□□□□□□□

5. Trimester:  A. first ( )  B. second ( )  C. third ( )

6. The presence of hydronephrosis in pregnant women:
   A. Yes ( )  B. No ( )

7. Classification of hydronephrosis:
   A. Mild ( )  B. Moderate ( )  C. Sever ( )

8. Location of hydronephrosis:
   A. Both kidneys ( )  B. RT kidney ( )  C. LT kidney ( )

9. Symptoms:
   A. RT Lion pain ( )  B. LT Lion pain ( )
   C. Bilateral Lion Pain ( )  D. Pain less ( )

10. GA:
    A. First trimester by GS ( ) Weeks  CRL ( ) Weeks
    B. Second trimester by BPD ( ) Weeks
    C. Third trimester by FL ( ) Weeks
Fig 5.1: sonogram for pregnant women who is 30 years old in second trimester (28 week), no Hydronephrosis seen.
Fig 5.2: sonogram for pregnant women who is 24 years old in second trimester (26 weeks), have mild hydronephrosis in RT kidney.
Fig 5.3: sonogram for pregnant women who is 30 years old in second trimester (14 weeks), have mild hydronephrosis in RT kidney.
fig. 5.4: sonogram for pregnant women who is 24 years old in second trimester (27 weeks), have mild hydronephrosis in RT kidney.
Fig 5.5: sonogram for pregnant women who is 27 years old in second trimester (20 weeks), have mild hydronephrosis in RT kidney.
Fig 5.6: sonogram for pregnant women who is 25 years in second trimester (20 weeks), have mild hydronephrosis in RT kidney.
Fig 5.7: sonogram for pregnant women who is 20 years old in second trimester (21 weeks), have mild hydronephrosis in RT kidney.
Fig 5.8: sonogram for pregnant women who is 16 years in second trimester (24 weeks), have mild hydronephrosis in RT kidney.
Fig 5.9: sonogram for pregnant women who is 29 years old in second trimester (23 weeks), have mild hydrenephrosis in RT kidney.
Fig 5.10: Sonogram for pregnant women who is 30 years in third trimester (36 weeks), have mild hydronephrosis in RT kidney.
Fig 5.11: sonogram for pregnant women who is 23 years old in third trimester (33 weeks), who have mild hydronephrosis in RT kidney.
Fig 5.12: sonogram for pregnant women who is 40 years old in third trimester (36 weeks), have mild hydronephrosis in RT kidney.
Fig 5.13: sonogram for pregnant women who is 30 years old in second trimester (23 weeks), no hydronephrosis seen
Fig 5.14: sonogram for pregnant women who is 39 years old in second trimester (21 weeks), have mild hydronephrosis in RT kidney.
Fig 5.15: sonogram for pregnant women who is 23 years old in first trimester (10 weeks), no hydronephrosis seen.
Fig 5.16: sonogram for pregnant women who is 23 years old in first trimester (7 weeks), no hydronephrosis seen.
Fig 5.17: sonogram for pregnant women who is 24 years old in first trimester (9 weeks), no hydronephrosis seen.
Fig 5.18: sonogram for pregnant women who is 22 years old in first trimester (9 weeks), no hydronephrosis seen.
Fig 5.19: sonogram for pregnant women who is 33 years old in third trimester (30 weeks), have mild hydronephrosis in RT kidney.
Fig 5.20: sonogram for pregnant women who is 34 years old in first trimester (9weeks), no hydronephrosis seen.
Fig 5.21: sonogram for pregnant women who is 37 years in third trimester (30 weeks), have mild hydronephrosis in LT kidney.
Fig 5.22: sonogram for pregnant women who is 23 years in third trimester (31 weeks), have mild hydronephrosis in RT kidney.
Fig 5.23: sonogram for pregnant women who is 30 years old in third trimester (37 weeks), have mild hydronephrosis in RT kidney.
Fig 5.24: sonogram for pregnant women who is 26 years old in second trimester (14 weeks + 5 days), have mild hydronephrosis in RT kidney.
Fig 5.25: sonogram for pregnant women who is 17 years old in third trimester (29 weeks), have moderate hydronephrosis in RT kidney.
Fig 5.26: sonogram for pregnant women who is 27 years old in first trimester (8 weeks), no hydronephrosis.
Fig 5.27: sonogram for pregnant women who is 17 years in third trimester (31 weeks), have moderate hydrenephrosis in both kidneys.
Fig 5.28: sonogram for pregnant women who is 20 years old in first trimester (9 weeks), no hydronephrosis seen.
Fig 5.29: sonogram for pregnant women who is 27 years in third trimester (32 weeks), have moderate hydrinephrosis in RT kidney.
Fig 5.30: sonogram for pregnant women who is 17 years in first trimester (10), no hydronephrosis seen.